

CLAIM 1. A compression module for a heating or air conditioning system, said module including:

- a primary compressor;
- a booster compressor;
- at least said primary compressor being an unloadable positive displacement compressor;
- a sensor for sensing the temperature of outdoor ambient air; and
- a controller, said controller being responsive to signals from said sensor commensurate with the temperature of outdoor ambient air to operate said primary compressor and said booster compressor in a predetermined operating sequence.

CLAIM 2. A compressor module as in Claim 1, wherein said predetermined operating sequence for heating includes the following:

- (a) allow partial capacity operation of said primary compressor when the outdoor ambient temperature is in the range of about 50°-75°F;
- (b) allow full capacity operation of said primary compressor when the outdoor ambient temperature is in the range of about 43°F - 50°F;
- (c) allow full capacity operation of said booster compressor and partial capacity operation of said primary compressor when the outdoor ambient temperature is in the range of about 33°F - 43°F;
- (d) allow full capacity operation of said booster compressor, and full capacity operation of said primary compressor when the outdoor ambient temperature is in the range of about 15°F - 33°F.

CLAIM 3. A compressor module as in Claim 1, wherein:

said primary compressor is a multiple-cylinder compressor.

CLAIM 4. A compressor module as in Claim 1, wherein:

said booster compressor is a single speed compressor or a two speed compressor.

CLAIM 5. A compressor module as in Claim 1, wherein:

the displacement of said booster compressor is about 30% to about 70% greater than the displacement of said primary compressor.

CLAIM 6. A compressor module as in Claim 1, wherein:

the coefficient of performance (C.O.P.) of the system for heating is at least 1.5 for the conditions of 0°F outdoor ambient temperature and 70°F indoor heated space temperature.

CLAIM 7. A compression module as in Claim 1, including:

an inlet to said primary compressor for the supply of working fluid to said primary compressor;

an inlet to said booster compressor for the supply of working fluid to said booster compressor;

a supply line from the discharge from said booster compressor to the inlet to said primary compressor; and

a lubricant management system, said system having:

- (a) an aspiration tube extending from the lubricant sump of said primary compressor to the intake of said primary compressor,
- (b) an aspiration tube extending from the lubricant sump of said booster compressor to the intake of said booster compressor,
- (c) a liquid trap in the supply line to the inlet to said booster compressor, and
- (d) a liquid trap in the supply line between the discharge from said booster compressor to the intake to said primary compressor.

CLAIM 8. A method of operating in sequence a heating system having a primary compressor and a booster compressor, the method including the steps of:

- (a) sensing the outdoor ambient temperature;
- (b) allowing partial capacity operation of said primary compressor when the outdoor ambient temperature is in the range of about 50°-75°F;
- (c) allowing full capacity operation of said primary compressor when the outdoor ambient temperature is in the range of about 43°F - 50°F;
- (d) allowing full capacity operation of said booster compressor and partial capacity operation of said primary compressor when the outdoor ambient temperature is in the range of about 33°F - 43°F;
- (e) allowing full capacity operation of said booster compressor, and full capacity operation of said primary compressor when the outdoor ambient temperature is in the range of about 15°F - 33°F.

CLAIM 9. The method of Claim 8, including the step of:

allowing operation of back-up resistance heating when the outdoor ambient temperature is about 15°F or lower.

CLAIM 10. A compressor module as in Claim 1, wherein said predetermined operating sequence for cooling includes the following:

- (a) allow partial capacity operation of said primary compressor when the outdoor ambient temperature is in the range of about 60°F - 85°F;
- (b) allow full capacity operation of said primary compressor when the outdoor ambient temperature is in the range of above about 85°F;
- (c) allow full capacity operation of said primary compressor and full capacity operation of said booster compressor when the outdoor ambient temperature is in the range of about 105°F or higher.

CLAIM 11. A compression module for a heat pump system, said module including:

- a primary compressor;
- a booster compressor;
- at least said primary compressor being a multi-cylinder unloadable compressor;
- each of said compressors having an inlet and a supply line connected to said inlet;
- a sensor for sensing the temperature of outdoor ambient air;
- a thermostat for sensing the temperature of a volume of air to be heated; and
- a controller, said controller being responsive to signals from said sensor

commensurate with the temperature of outdoor ambient air, and to signals from said thermostat commensurate with the temperature of the air to be heated to operate said primary compressor, said booster compressor and said economizer in a predetermined operating sequence.

CLAIM 12. A compressor module as in Claim 11, wherein said predetermined operating sequence for heating includes the following:

- (f) allow partial capacity operation of said primary compressor when the outdoor ambient temperature is in the range of about 50°-75°F;
- (g) allow full capacity operation of said primary compressor when the outdoor ambient temperature is in the range of about 43°F - 50°F;
- (h) allow full capacity operation of said booster compressor and partial capacity operation of said primary compressor when the outdoor ambient temperature is in the range of about 33°F - 43°F;
- (i) allow full capacity operation of said booster compressor, and full capacity operation of said primary compressor when the outdoor ambient temperature is in the range of about 15°F - 33°F.

CLAIM 13. A compressor module as in Claim 11, wherein:

the ratio of the displacement of said booster compressor to the displacement of said primary compressor is at least about 1.3 to 1.

CLAIM 14. A compressor module as in claim 11, wherein:

the heating coefficient of performance (C.O.P.) of the heat pump system is at least about 1.5 for the conditions of 0°F outdoor ambient temperature and 70°F indoor heated space temperature.

CLAIM 15. A compression module as in Claim 11, wherein:

100% of the capacity of said primary compressor is greater than the ordinary cooling requirements of the heat pump system.

CLAIM 16. A compression module for a heat pump system, said module including:

- a primary compressor;
- a booster compressor;
- at least said primary compressor being a multi-cylinder unloadable compressor;
- a sensor for sensing the temperature of outdoor ambient air;
- a thermostat for sensing the temperature of a volume of air to be heated; and
- a controller, said controller being responsive to signals from said sensor

commensurate with the temperature of outdoor ambient air, and to signals from said thermostat commensurate with the temperature of the air to be heated to operate said primary compressor and said booster compressor in a predetermined heating operating sequence including the following:

- (a) allow partial capacity operation of said multi-cylinder primary compressor when the outdoor ambient temperature is in the range of about 50°-75°F;
- (b) allow full capacity operation of said multi-cylinder primary compressor when the outdoor ambient temperature is in the range of about 43°F - 50°F;
- (c) allow full capacity operation of said booster compressor and partial capacity operation of said multi-cylinder primary compressor when the outdoor ambient temperature is in the range of about 33°F - 43°F;

- (d) allow full capacity operation of said booster compressor, and full capacity operation of said multi-cylinder primary compressor when the outdoor ambient temperature is in the range of about 15°F - 30°F;
- (e) allow operation of back-up resistance heating when the outdoor ambient temperature is about 15°F or lower.

CLAIM 17. A compressor module as in Claim 16, wherein:

the ratio of the displacement of said booster compressor to the displacement of said primary compressor is at least about 1.3 to 1.

CLAIM 18. A compressor module as in claim 16, wherein:

the heating coefficient of performance (C.O.P.) Of the heat pump system is at least about 1.5 for the conditions of 0°F outdoor ambient temperature and 70°F indoor heated space temperature.

CLAIM 19. A compression module as in Claim 16, wherein:

100% of the capacity of said primary compressor is greater than the ordinary cooling requirements of the heat pump system.

CLAIM 20. A compressor module as in Claim 1, wherein:

said booster compressor is a single speed compressor.

CLAIM 21. A compressor module as in Claim 16, wherein:

said controller is responsive to signals from said sensor commensurate with the temperature of outdoor ambient air, and to signals from said thermostat commensurate with the temperature of the air to be cooled to operate said primary compressor, and said booster compressor in a predetermined cooling operating sequence, including the following:

- (a) allow partial capacity operation of said primary compressor when the outdoor ambient temperature is in the range of about 60°F - 85°F;
- (b) allow full capacity operation of said primary compressor when the outdoor ambient temperature is in the range of above about 85°F;
- (c) allow full capacity operation of said primary compressor and full capacity operation of said booster compressor when the outdoor ambient temperature is in the range of about 105°F or higher.

CLAIM 22. A method of operating in heating sequence a heat pump system having a multi-cylinder unloadable primary compressor and a booster compressor, the method including the steps of:

- (a) sensing the outdoor ambient temperature;
- (b) allowing partial capacity operation of said multi-cylinder primary compressor when the outdoor ambient temperature is in the range of about 50°-75°F;
- (c) allowing full capacity operation of said multi-capacity primary compressor when the outdoor ambient temperature is in the range of about 43°F - 50°F;
- (d) allowing full capacity operation of said booster compressor and partial capacity operation of said multi-cylinder primary compressor when the outdoor ambient temperature is in the range of about 33°F - 43°F;
- (e) allowing full capacity operation of said booster compressor, and full capacity operation of said multi-cylinder primary compressor, when the outdoor ambient temperature is in the range of about 15°F - 33°F;
- (f) allowing operation of back-up resistance heating when the outdoor ambient temperature is about 15°F or lower.

CLAIM 23. A method of operating in cooling sequence a heat pump system having a multi-cylinder unloadable primary compressor, and a booster compressor, the method including the steps of:

- (a) sensing the outdoor ambient temperature;
- (b) allowing partial capacity operation of said primary compressor when the outdoor ambient temperature is in the range of about 60°F - 85°F;
- (c) allowing full capacity operation of said primary compressor when the outdoor ambient temperature is in the range of above about 85°F;
- (d) allowing full capacity operation of said primary compressor and full capacity operation of said booster compressor when the outdoor ambient temperature is in the range of about 105°F or higher.

CLAIM 24. A compression module for a heat pump system, said module including:

a primary compressor;

a booster compressor

at least said primary compressor being a multi-cylinder unloadable compressor;

each of said compressors having an inlet and a supply line connected to said inlet;

a supply line from the discharge from said booster compressor to the inlet to said primary compressor;

an economizer;

a sensor for sensing the temperature of outdoor ambient air;

a thermostat for sensing the temperature of a volume of air to be heated; and

a controller, said controller being responsive to signals from said sensor

commensurate with the temperature of outdoor ambient air, and to signals from said

thermostat commensurate with the temperature of the air to be heated to operate said

primary compressor, said booster compressor and said economizer in the following

heating sequence:

- (a) allow partial capacity operation of said multi-cylinder primary compressor when the outdoor ambient temperature is in the range of about 50°-75°F;
- (b) allow full capacity operation of said multi-cylinder primary compressor when the outdoor ambient temperature is in the range of about 43°F - 50°F;
- (c) allow full capacity operation of said booster compressor and partial capacity operation of said multi-cylinder primary compressor when

the outdoor ambient temperature is in the range of about 33°F - 43°F;

- (d) allow full capacity operation of said booster compressor, and partial capacity operation of said multi-cylinder primary compressor, and said economizer when the outdoor ambient temperature is in the range of about 25°F - 33°F;
- (e) allow full capacity operation of said booster compressor, and full capacity operation of said multi-cylinder primary compressor, and said economizer when the outdoor ambient temperature is in the range of about 15°F - 25°F;
- (f) allow operation of back-up resistance heating when the outdoor ambient temperature is about 15°F or lower.

CLAIM 25. A compression module for a heat pump system, said module including:

a primary compressor;

a booster compressor

at least said primary compressor being a multi-cylinder unloadable compressor;

each of said compressors having an inlet and a supply line connected to said inlet;

a supply line from the discharge from said booster compressor to the inlet to said primary compressor;

an economizer;

a sensor for sensing the temperature of outdoor ambient air;

a thermostat for sensing the temperature of a volume of air to be cooled; and

a controller, said controller being responsive to signals from said sensor

commensurate with the temperature of outdoor ambient air, and to signals from said

thermostat commensurate with the temperature of the air to be heated to operate said

primary compressor, said booster compressor and said economizer in the following

cooling sequence:

- (a) allow partial capacity operation of said multi-cylinder primary compressor when the outdoor ambient temperature is in the range of about 60°F - 85°F;
- (b) allow full capacity operation of said multi-cylinder primary compressor when the outdoor ambient temperature is in the range of above about 85°F;
- (c) allow full capacity operation of said multi-cylinder primary compressors and full capacity operation of said booster compressor when outdoor ambient temperature is in the range of about 105°F.

CLAIM 26. The compression module of Claim 25, including:

allow operation of said economizer and full capacity operation of said primary compressor and full capacity operation of said booster compressor.

CLAIM 27. A compressor module as in Claim 24, including:

a lubricant management system, said system having:

- (a) an aspiration tube extending from the lubricant sump of said primary compressor to the intake of said primary compressor,
- (b) an aspiration tube extending from the lubricant sump of said booster compressor to the intake of said booster compressor,
- (c) a liquid trap in the supply line to the inlet to said booster compressor, and
- (d) a liquid trap in the supply line between the discharge from said booster compressor to the intake to said primary compressor.

CLAIM 28. A compressor module as in Claim 24, wherein:

the displacement of said booster compressor is about 10% - about 50% greater than the displacement of said primary compressor.

CLAIM 29. A compressor module as in Claim 24, wherein:

the ratio of the displacement of said booster compressor to the displacement of said primary compressor is at least about 1.3 to 1.

CLAIM 30. A compressor module as in claim 24, wherein:

the coefficient of performance (C.O.P.) Of the heat pump system is at least about 2 for the conditions of 0°F outdoor ambient temperature and 70°F indoor heated space temperature.

CLAIM 31. A compression module as in Claim 24, wherein:

100% of the capacity of said primary compressor is greater than the ordinary cooling requirements of the heat pump system.

CLAIM 32. A compressor module as in Claim 24, wherein:

said booster compressor is a single speed compressor.

CLAIM 33. A compressor module as in Claim 24, wherein:

each of said booster compressor and said primary compressor is a twin-single compressor.

CLAIM 34. A method of operating in heating sequence a heat pump system having a primary multi-cylinder unloadable compressor, a booster compressor and an economizer, the method including the steps of:

- (a) sensing the outdoor ambient temperature;
- (b) allowing partial capacity operation of said multi-cylinder primary compressor when the outdoor ambient temperature is in the range of about 50°-75°F;
- (c) allowing full capacity operation of said multi-cylinder primary compressor when the outdoor ambient temperature is in the range of about 43°F - 50°F;
- (d) allowing full capacity operation of said booster compressor and partial capacity operation of said multi-cylinder primary compressor when the outdoor ambient temperature is in the range of about 33°F - 43°F;
- (e) allowing full capacity operation of said booster compressor, and partial capacity operation of said multi-cylinder primary compressor, and said economizer when the outdoor ambient temperature is in the range of about 25°F - 33°F;
- (f) allowing full capacity operation of said booster compressor, and full capacity operation of said multi-cylinder compressor, and said economizer when the outdoor ambient temperature is in the range of about 15°F - 25°F;
- (g) allowing operation of back-up resistance heating when the outdoor ambient temperature is about 15°F or lower.

CLAIM 35. A method of operating in cooling sequence a heat pump system having a multi-cylinder unloadable primary compressor, a booster compressor and an economizer, the method including the steps of:

- (a) sensing the outdoor ambient temperature;
- (b) allowing partial capacity operation of said multi-cylinder primary compressor when the outdoor ambient temperature is in the range of about 60°F - 85°F;
- (c) allowing full capacity operation of said multi-cylinder primary compressor when the outdoor ambient temperature is in the range of above about 85°F; and
- (d) allowing full capacity operation of said multi-cylinder primary compressor and full capacity operation of said booster compressor when the outdoor ambient temperature is in the range of about 105°F.

CLAIM 36. The method as in Claim 35, including the step of:

operating said economizer along with full capacity operation of said multi-cylinder primary compressor and full capacity operation of said booster compressor.

CLAIM 37. A lubricant management system for at least two compressors connected in a compression system, the lubricant management system having:

in each compressor, an aspiration tube extending from the lubricant sump of the compressor to the intake to the compressor; and

trap means to prevent the migration of lubricant to at least one of said compressors when said one compressor is not operating.

CLAIM 38. A lubricant management system as in Claim 37, wherein:

said compressors are connected in series.

CLAIM 39. A lubricant management system as in Claim 38, wherein said trap means includes:

a first liquid trap in the intake line to one of said compressors; and

a second liquid trap in a supply line from the discharge from said one compressor to the intake of another of said compressors.

CLAIM 40. A lubricant management system as in Claim 37, wherein:

said compressors are connected in parallel.

CLAIM 41. A compression module for a heating system, said module including:

a multi-cylinder unloadable compressor;

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a sensor for sensing the temperature of outdoor ambient air; and

a controller, said controller being responsive to signals from said sensor commensurate with the temperature of outdoor ambient air, to operate said multi-cylinder compressor in a predetermined operating sequence for heating as follows:

- (a) allow partial capacity operation of said multi-cylinder compressor when the outdoor ambient temperature is in the range of about 50°F - 75°F;
- (b) allow full capacity operation of said multi-cylinder compressor when the outdoor ambient temperature is in the range of about 43°F - 50°F;
- (c) allow operation of back-up heating for any ambient temperature below and up to 43°F.

CLAIM 42. A compression module for an air conditioning system, said module including:

a multi-cylinder unloadable compressor;
a sensor for sensing the temperature of outdoor ambient air; and
a controller, said controller being responsive to signals from said sensor commensurate with the temperature of outdoor ambient air, to operate said twin-single compressor in a predetermined operating sequence for cooling as follows:

- (a) allow partial capacity operation of said multi-capacity compressor when cooling is called for by a first step of said thermostat and the outdoor ambient temperature is in the range of about 60°F - 85°F;
- (b) allow full capacity operation of said multi-cylinder compressor when cooling is called for by said thermostat and the outdoor ambient temperature is above about 85°F.

CLAIM 43. The compression module of Claim 41, wherein said operating sequence also includes:

allow full capacity operation of said multi-capacity compressor on manual selection of a second step of said thermostat, and when the outdoor ambient temperature is at least about 60°F.

CLAIM 44. A method of operating in sequence a heating system having multi-cylinder unloadable compressor, a method including the steps of:

- (a) sensing the outdoor ambient temperature;
- (b) allowing partial capacity operation of said multi-cylinder compressor when the outdoor ambient temperature is in the range of about 50°F - 75°F;
- (c) allowing full capacity operation of said multi-cylinder compressor when the outdoor ambient temperature is in the range of about 43°F - 50°F;
- (d) allowing operation of back-up heating when the outdoor ambient temperature is any temperature below or up to about 43°F.

CLAIM 45. A method of operating in cooling sequence a heat pump system having a multi-cylinder compressor, the method including the steps of:

- (a) sensing the outdoor ambient temperature;
- (b) allowing partial capacity operation of said multi-cylinder primary compressor when cooling is called for by an indoor thermostat when the outdoor temperature is in the range of about 60°F - 85°F; and
- (c) allowing full capacity operation of said multi-cylinder primary compressor when cooling is called for by an indoor thermostat when the outdoor ambient temperature is in the range of above about 85°F.

CLAIM 46. The method as in Claim 45 including the step of:

allowing full capacity operation said multi-cylinder compressor on manual operation of an indoor thermostat when outdoor ambient temperature is about 60°F.